

## A Preliminary Study of the Genera *Acarospora* and *Pleopsidium* in South America

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ABSTRACT. – Thirteen species of *Acarospora* and *Pleopsidium chlorophanum* are treated from South America. *Acarospora terrigena* from Brazil is described as new to science. A neotype is designated for *Acarospora boliviana*. *Acarospora obnubila* and *A. obpallens* are reported as new to South America.

KEYWORD: Acarosporaceae.

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### INTRODUCTION

The genus *Acarospora* was erected by Massalongo (1852) with the yellow terricolous *Acarospora schleicheri* (Ach.) A. Massal. as the type of the genus. *Acarospora* is characterized by polyspory, simple, hyaline ascospores, aspicilioid or pseudo-lecanorine apothecia, and bitunicate, but effectively unitunicate, asci with a non-amyloid tholus (Reeb et al 2004; Knudsen 2007). *Acarospora* is a cosmopolitan genus containing approximately 200 saxicolous and terricolous crustose and squamulose species worldwide, which are usually abundant in open, sunny microhabitats. We do not recognize the subgenera of *Phaeothallia* and *Xanthothallia* as representing the true phylogeny of the genus (Reeb et al 2004; Knudsen 2007). The genus is in need of a worldwide revision and, unfortunately, many problems cannot be solved within a regional approach.

The only unified study of the genus in South America was done by Magnusson (1929b) in his global monograph, where he reported nineteen species but did not include either species of *Pleopsidium*, then included in *Acarospora*.

A total of thirty-eight species of *Acarospora* have been described or reported from South America (Aptroot 2002; Calvelo & Liberatore 2002; Feuerer et al. 1998; Feuerer 2007; Galloway & Quilhot 1998; Grassi 1950; Hue 1909; Magnusson 1929a, 1929b, 1947, 1956; Osorio 1972, 1992; Santesson, 1944; Zahlbruckner 1909, 1926). Some of them do not belong to *Acarospora* according to Magnusson (1929b), including *A. plumbeocaesia* Zahlbr. which is an *Aspicilia* with eight spores, *A. skottsbergii* Zahlbr. which is probably a sterile *Buellia*, and *A. subglobosa* (Müll. Arg.) Hue which is a cyanolichen (Galloway & Quilhot 1998). A number of species need detailed investigation in a future study including *A. brasiliensis* Zahlbr., *A. catamarcae* H. Magn., *A. punae* I.M. Lamb, *A. regnelliana* R. Sant., *A. sparsiuscula* H. Magn., *A. theleomma* I.M. Lamb, and *A. trachyticola* (Müll. Arg.) Hue.

Many determinations need to be re-examined. For instance, the report of *A. extenuata* H. Magn. probably refers to *A. boliviana* H. Magn. (Grassi 1950; Calvelo & Liberatore 2002). Although *A. schleicheri* has not been seen from the continent, the species concept *sensu* Weber (1968; Knudsen 2004) has been used and refers to several possible species (Calvelo & Liberatore, 2002; Galloway & Quilhot 1998; Osorio 1972, 1992). *Acarospora mendozana* H. Magn., *A. sanguinascens* Zahlbr. and *A. subcastenaea* (Nyl.) Hue are considered synonyms of *A. bullata* Anzi (Magnusson 1929b, Knudsen 2007),

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*A. dissipata* H. Magn. is a synonym of *A. chrysops* (Tuck.) H. Magn., and *A. terrestris* (Nyl.) H. Magn. and *A. malmeana* H. Magn. are synonyms of *A. rhabarbarina* Hue, thus reducing the number of actual species reported. At this time it is impossible to say precisely how many species of *Acarospora* occur in South America. We discuss thirteen species of *Acarospora* and *Pleopsidium chlorophanum* in this preliminary study. Further species new to science are expected with *A. oligyrophorica* Aptroot (2002) being the first new *Acarospora* to be described from the continent in the 21<sup>st</sup> century.

## MATERIALS AND METHODS

Valerie Reeb collected *Acarospora* taxa in Bolivia in 2002 and her collections and duplicates (DUKE & LPB) form the basis of our study. The Reeb collections had not been accessioned into LPB at the time paper was written. Additional specimens were supplied by ASU, B, CETC, COLO, DUKE, FH, H-NYL, MSC, NY, S, and UV. Valerie Reeb traveled to Paris Herbarium (PC) in 2006 and obtained from Bruno Dennerlé photographs of type material of *A. rhabarbarina*, *A. terrestris*, and *A. xanthophana* (Nyl.) Jatta, which were compared with specimens from H-NYL. Anders Nordin supplied photographs of type material in UPS. The specimens were examined using hand sections and standard light microscopy, in water and 10% solution of KOH, and measured in water. Spot tests were administered. A selection of 47 specimens from South and North America were selected and studied with HPLC by the second author using standard methods (Elix et al. 2003). The descriptions of the species are based on the examination of specimens.

## KEY TO SPECIES

This key only applies to species treated in this paper and specimens should be carefully compared against descriptions and if possible authentic specimens as other species are expected to occur in South America. The characters used are average and for instance some effigurate species may lack outer lobes and some species may be broadly attached but appear squamulose through development of lobes in nutrient-rich habitats.

1. Thallus **yellow**.....2
  2. Thallus effigurate.....3
    3. Upper surface rugulose; norstictic acid present.....*Acarospora rouxii*
    3. Upper surface not rugulose; norstictic acid absent.....4
      4. Thallus areolate; apothecia immersed.....*Acarospora boliviana*
      4. Thallus squamulose; apothecia biatorine.....*Pleopsidium chlorophanum*
  2. Thallus not effigurate.....5
    5. On soil.....*Acarospora rhabarbarina*
    5. On rock.....6
      6. Upper surface glossy.....*Acarospora rhabarbarina*
      6. Upper surface dull.....7
        7. Thallus squamulose, with stipe; underside black.....*Acarospora brouardii*
        7. Thallus not squamulose, without a stipe; underside not black.....8
          8. Areoles with multiple, contiguous apothecia; algal layer interrupted.....*Acarospora xanthophana*
          8. Areoles without multiple contiguous apothecia; algal layer not interrupted.....*Acarospora chrysops*
1. Thallus **not yellow**.....9
  9. Thallus KC+ red or pink (crystals absent).....10
    10. Thallus effigurate, lacking pits around apothecium.....*Acarospora bullata*
    10. Thallus not effigurate, with pits around apothecium.....*Acarospora obpallens*
  9. Thallus K- or K+ yellow to red (crystals present).....11

11. Norstictic acid present.....*Acarospora lorentzii*  
 11. Norstictic acid absent..... 12  
     12. On soil.....*Acarospora terrigena*  
     12. On rock.....13  
     13. Upper surface white pruinose, spores broadly ellipsoid.....*Acarospora strigata*  
     13. Upper surface not white pruinose, spores broadly or narrowly ellipsoid..... 14  
         14. Spores broadly ellipsoid (3-7 x 2-3.5 µm).....*Acarospora altoandina*  
         14. Spores narrow ellipsoid (3-6 x 1.7-2.2 µm).....*Acarospora obnubila*

## THE SPECIES

*Acarospora altoandina* H. Magn., Goteborgs Kungl. Vetensk.- & Vitterhets.-Samhalles Handl., sjätte  
 foljden, ser. B, 6(17): 26-27 (1956).

### PLATE 1, FIGURES 1-4.

DESCRIPTION. – Thallus areolate or squamulose, contiguous (in holotype) or dispersed among *Acarospora xanthophana* (in Reeb specimens), often distinctly lobate at margins of contiguous thalli or around some dispersed squamules. Areoles or squamules 0.5-3.0 mm wide, angular to rounded, broadly attached at first, but become distinctly stipitate and squamulose, the lower surface white or darkened by adhering substrate. Upper surface pale to dark brown, matt; well-developed squamules rugulose. Areoles multiplying by division, the stipe splitting and dividing so individual areoles or squamules may contain many individualizing units divided by fissures. Algal layer discontinuous and jagged, up to 200 µm deep, divided by hyphal bands which form prosoplectenchymatous to sub-paraplectenchymatous upper cortex which lacks an epinecral layer or syncortex *sensu* Knudsen (2007). The hyphal bands are responsible for the rugulose upper surface and fissures of future vegetative divisions. Apothecia one or two per areole, squamule or unit (thus many for dividing squamules); disc immersed, pale reddish brown, epruinose, rough and concave, 0.2-1.0 mm wide. Hymenium hyaline, 130-160 µm high. Epihymenium red-brown. Parathecium, 10-50 µm thick, often forming a crown concolorous with the surrounding thallus (in Bolivian specimens but not apparent in holotype), 70-100 µm wide at surface of thallus, narrowing into the hypothecium; hypothecium 15-20 µm thick. Paraphyses ca. 2 µm diam. at mid-level, apices barely expanded in pigment caps, septa not always distinct. Asci 110-125 x 25 µm, narrowly clavate; ascospores about 100 per ascus, broadly ellipsoid, 3-7 x 2-3.5 µm. Spot tests negative. Secondary metabolites absent.

SUBSTRATE AND ECOLOGY. – This species occurs on exposed acidic and volcanic rocks above 3500 meters. In the holotype the thallus is contiguous but in the Bolivian specimens thalli appear to be competing with *A. xanthophana* which stimulates stipe elongation as it does in several other species (such as *A. thamnina* (Tuck.) Herre and *A. obnubila* H. Magn.).

DISTRIBUTION. – The species is currently known only from the mountains of Argentina and Bolivia.

DISCUSSION. – *Acarospora altoandina* is a distinctive South America endemic. The interrupted algal layer is shared with *A. boliviana*, *A. rouxii* K. Knudsen, Elix & Reeb and *A. xanthophana*. In these specimens, cortical width is often uneven and cortical hyphae vary from prosoplectenchymatous to paraplectenchymatous. The hyphal bands through the algal layer eventually form a rugulose or uneven upper surface. More specimens should be examined to complete a comprehensive revision of this species as specimens used here were small and only photograph of type and protologue were used for determination.

SPECIMENS EXAMINED. – **ARGENTINA:** Jujuy, Casabindo, 3600 m, on stone, *Cabrera* (UPS, holotype, only photographs seen). **BOLIVIA:** Potosi, on S slope of the volcano Tunupa, 19° 51'38.2" S, 67° 38'13.9" W, 4376 m, on volcanic rock, *Reeb 14-V-02/6* (DUKE); 19°51'39.5" S, 67°38'12.2" W, 4376 m, on volcanic rock, *Reeb 14-V-02/4* (DUKE).

*Acarospora boliviana* H. Magn., Kungl.-Akad. Handlingar 7, 4: 92 (1929). TYPE: **PERU**: Hochfläche von Ollantaitambo (Urubambatal) bei Cuzco, F. Mattick 701 (B, neotype **designated here**).

**PLATE 1, FIGURE 5.**

DESCRIPTION. – Thallus effigurate, 2-7 cm wide, orbicular to irregular; confluent thalli without clear center or outer edge; center rimose-areolate in orbicular thalli; areoles angular, 0.2-1 mm wide, less than 1 mm thick, broadly attached to the substrate, the outer areoles usually bilobed, rounded, 0.2-0.5 mm wide. Upper surface yellow, matt to glossy, smooth, but becoming striate, and eventually rugulose. Upper cortex, usually thin (30-40  $\mu\text{m}$  thick) but uneven, cells obscure in water or KOH. Algal layer discontinuous and jagged, divided by hyphal bands. Apothecia usually one to eight per areole towards the center of orbicular thalli; disc immersed, yellow to a pale red-brown, flat, rough, epruinose, 0.1-0.6 mm wide, sometimes with an umbo. Hymenium hyaline, 150-200  $\mu\text{m}$  high. Epihymenium, pale yellow to reddish-yellow. Parathecium narrow to very indistinct. Paraphyses ca. 1.0-1.5 wide at mid-level, apices not expanded, in yellow to reddish pigmented gel. Asci 80-100 x 20-30  $\mu\text{m}$ , clavate; ascospores 100 per ascus, narrow ellipsoid, 4-5 x 2  $\mu\text{m}$ . Spot tests negative. Secondary metabolites: rhizocarpic acid (major), traces of epanorin and conrhizocarpic acid.

SUBSTRATE AND ECOLOGY. – This species occurs on volcanic and acid rocks above 500 m elevation and was reported also from calcareous rock (Magnusson 1929b).

DISTRIBUTION. – The species is currently known from the mountains of Argentina, Bolivia, and Peru.

DISCUSSION. – The holotype of *A. boliviana* (reputedly in PC) collected by Mandon (Magnusson 1929) could not be located and a specimen collected by Mattick is selected as neotype. Our description differs from Magnusson in the observation of an interrupted algal layer.

SPECIMENS EXAMINED. – **ARGENTINA**: Catamarca, Nevados de Auconquiija, SE slope of Nevados Pabellón de la Abr a Grande, 4800 m, *Filipovich 5630* (MSC); Jujuy, Tilcara, Pucará de Tilcara, *Krapovickas & Cristóbal* (CTES 18504); de La Rioja: along route 9, ca. 26 km N of Bazan, 28° 59' S, 66° 38' W, c. 550 m, on acidic rock, *Nash 28129* (ASU). **BOLIVIA**: Potosí, Refuge of Andean Animals Eduardo Avaroa, Laguna Colorado, on the rocky slope behind the station, 22°10'39.9" S, 67°49'31.3" W, 4350 m, *Reeb 19-V-02/5 & Reeb 19-V-02/5* (DUKE). **PERU**: Hochfläche von Ollantaitambo (Urubambatal) bei Cuzco, *Mattick 701* (B, neotype).

*Acarospora brouardii* de Lesd., Lich. Mexique, Suppl. 1, p. 15 (1922).

**PLATE 2, FIGURES 6-8.**

DESCRIPTION. – Thallus squamulose; squamules dispersed or contiguous and imbricate, up to 4 mm wide, with a black to dark brown stipe, rounded, convex, epruinose. Upper surface dull yellow, smooth to rough; lower surface distinctly carbonized and corticate. Upper cortex prosoplectenchymatous, 60-130  $\mu\text{m}$  thick formed by hyphal bands interrupting the algal layer, cells various from angular to round. Apothecia 1-16 per squamule; disc immersed, yellowish to reddish-brown, punctiform, slit-like or round, epruinose, 0.1-0.4 wide. Hymenium 130-170  $\mu\text{m}$  tall. Epihymenium greenish-yellow. Paraphyses 2.0-2.5  $\mu\text{m}$  diam. at mid-level, apices unexpanded. Parathecium 10-50  $\mu\text{m}$  thick narrowing to 50  $\mu\text{m}$  beneath the subhymenium. Asci 110-130 x 20-24  $\mu\text{m}$ , narrowly clavate. Ascospores 100-200 spores per ascus, broadly ellipsoid, 4-6 x 2-3  $\mu\text{m}$ . Spot tests negative. Secondary metabolites: rhizocarpic acid.

SUBSTRATE AND ECOLOGY. – This species occurs on exposed volcanic and acid rocks; elevational range unknown.

DISTRIBUTION. – *Acarospora brouardii* is known from North America (southern Arizona and Mexico), Argentina (Calvelo & Liberatore 2002, specimen not verified) and Venezuela.

DISCUSSION. – This species can be determined by the large squamules and the black or dark brown lower surface and stipe. In South America it could be confused with well-developed squamules of *A. rhabarbarina* but the latter has a pale or brownish, mineral-stained lower surface and larger discs. In western North America and Mexico this species could be confused with well-developed squamules of *A. socialis* which has a pale lower surface (Knudsen 2007). We have only seen five specimens.

SPECIMENS EXAMINED. – **MEXICO:** Queretaro, Loma al Este, 1950 m, *Arsène 10730* (us, isotype). **VENEZUELA:** Edo Sucre, Parque Nacional Mochima Islas Caracas del Oeste, on unknown rock. *Guariglia 1838* (NY).

*Acarospora bullata* Anzi, Atti Soc. Ital. Sc. Nat. Milano, 11: 165 (1868). Synonyms: *Acarospora mendozana* H. Magn. (Knudsen 2007), *A. sanguinascens* Zahlbr. (Magnusson 1929b), *A. subcastanea* (Nyl.) Hue (Knudsen 2007).

#### PLATE 2, FIGURE 9.

DESCRIPTION. – Thallus determinate or rarely indeterminate, orbicular, with effigurate margin, up to 7 cm wide, areolate towards the center. Areoles less than 3 mm wide, the margin with 2-3 rounded lobes per areole, lobes 0.1-0.5 mm wide. Upper surface glossy or dull, varying from pale yellow brown to mahogany with black tones. Upper and lateral cortices paraplectenchymatous, 40-50(-100)  $\mu\text{m}$  thick; cells: (3-)5-6  $\mu\text{m}$  wide, sometimes opaque in water; syncortex: sometimes with visible periclinal hyphae, 4-30  $\mu\text{m}$  thick; eucortex: reddish-brown upper layer 5-20  $\mu\text{m}$  thick, lower portion hyaline and 15-40  $\mu\text{m}$  thick. The algal layer is  $\pm$  even, algal cells  $\pm$ arranged in vertical columns with strands sometimes extending into medulla. The medulla white, often obscure, intricately prosoplectenchymatous, continuous with attaching hyphae. Apothecia usually one per areole, up to 2 mm across; disc immersed, dark brown to black, flat, rough, epruinose, sometimes with inter-ascal plectenchyma forming surface of minute umbos, sometimes with parathecial crown. Hymenium hyaline, 90-150  $\mu\text{m}$  high. Epihymenium pale to dark brown. Parathecium usually wide, 70-50  $\mu\text{m}$  thick around the disc, often forming parathecial crown, narrowing beneath apothecium. Paraphyses 1.0-2.0  $\mu\text{m}$  wide at mid-level, apices  $\pm$ expanded to 4-5  $\mu\text{m}$ . Asci 60-100 x 15-28  $\mu\text{m}$ , clavate. Ascospores usually about 100 spores per ascus, usually narrowly ellipsoid but various, mostly 4.0-5.1 x 1.5-2.0  $\mu\text{m}$ . Spot tests: cortex KC+ red (a yellowish pigment diffuses from this and several other brown species in K). Secondary metabolites: gyrophoric acid (major), lecanoric acid (minor),  $\pm$ 3-hydroxygyrophoric acid (trace),  $\pm$ methyl lecanorate (trace).

SUBSTRATE AND ECOLOGY. – This species occurs on acid and volcanic rocks and can occur on calcareous rock in open situations from above 500 meters.

DISTRIBUTION. – *A. bullata* is known from Argentina and Chile from only historic collections. This widespread species also occurs in Europe, Asia and western North America. It is common in the arid mountains of the inland deserts of western North America.

DISCUSSION. – We use here the broad concept of *A. bullata* used by Magnusson which conflates measurements from European and California specimens (1929b). Claude Roux in reviewing this paper suggested *A. bullata* from Europe may represent a different species from California and South American specimens. At his request we re-examined specimens including the type material of *A. bullata* again. The minutely umbonate disc of European *A. bullata* can be found in some specimens from North and South America and appears to derive from remnants of the cortex dissolved in formation of fertile apothecium. Taxonomic measurements overlapped between specimens from the Americas and Europe. The main difference was that specimens of *A. bullata* from Germany and Italy have a dissected thallus surface which gives them a rugulose look and are sometimes pruinose. Molecular analysis is necessary. If California material, which matches well South American collections, is found to be a different taxon then specimens from North and South America should be called *A. subcastanea*.

In South America *Acarospora bullata* is rarely confused with other species but spot tests with KC/C may be inconclusive in some specimens (e.g. Magnusson 1929b reported *A. mendozana* and *A. subcastanea* to be C-), so TLC should be used.

SPECIMENS EXAMINED. – **ARGENTINA**: Mendoza, in viciniis montis Aconcagua, *Malme* (s, isotype of *A. mendozana*); Mendoza, in viciniis montis Aconcagua, *Malme* (S, as *Lecanora subcastanea*). **CHILE**: Quilmenco, Claude Gay (H-NYL, isotype of *L. subcastanea*).

*Acarospora chrysops* (Tuck.) H. Magn., Kungl.-Akad. Handlingar 7, 4: 64 (1929). Synonym: *Acarospora dissipata* H. Magn. (Knudsen 2007).

**PLATE 3, FIGURES 10-12.**

DESCRIPTION. – Thallus of dispersed areoles. Areoles 0.3-1(-2) mm wide, thin, broadly attached, with a thinner rim that can become lobate in nutrient-rich habitats, rarely showing signs of vegetative division. Upper surface yellow, usually matt, sometimes pruinose especially in the center. Upper cortex is paraplectenchymatous, 20-40  $\mu\text{m}$  thick, cells usually obscure, 1-3  $\mu\text{m}$  wide. Algal layer even. Medulla prosoplectenchymatous. Apothecia usually one per areole; disc immersed, sometimes expanding to cover the whole areole or raised above the thallus surface in a parathecial crown concolorous with the thallus; disc dull red to yellowish red, rough, flat, concave or convex,  $\pm$ with interascal sterile plectenchyma. Hymenium hyaline below but yellowish to reddish brown in the upper part merging into the epihymenium, 70-110  $\mu\text{m}$  tall. Paraphyses 1.5-2.0  $\mu\text{m}$  diam. at mid-level, apices slightly expanded, usually reddish-brown. Asci 55-90 x 15-20  $\mu\text{m}$ , clavate; ascospores 100-200 per ascus, usually narrowly ellipsoid 4-6 x 1.5-2.0(-2.5)  $\mu\text{m}$ . Pycnidia globose, 60-100  $\mu\text{m}$ ; conidia bacilliform, ca. 2 x 0.6  $\mu\text{m}$ . Spot test negative. Secondary metabolites: Rhizocarpic acid and/or epanorin (major).

SUBSTRATE AND ECOLOGY. – This species occurs on acid or volcanic rock. In harsh microhabitats the areoles are small and dispersed, but may be crowded and robust with well-developed lobes and large apothecia in nutrient-rich and moist habitats.

DISTRIBUTION. – In South America *A. chrysops* occurs in Brazil, Columbia, the Galapagos Islands and Venezuela. The species is also known from El Salvador (*Sipman 37851*, B) and Costa Rica (*Sipman 51061*, B) in Central America, Mexico and from Arizona and the Rocky Mountains to the southeastern United States. The species occurs from near sea level on Galapagos Islands to 2250 meters.

DISCUSSION. – *Acarospora chrysops* has a broad distribution. Only the epanorin chemotype appears to occur in the Galapagos Islands but these specimens are morphologically indistinguishable from the rest of the species.

In some cases *A. chrysops* may be difficult to distinguish from *A. rhabarbarina*, but the areoles of the former are generally thinner, broadly attached and more dispersed, the ascospores and paraphyses are narrower, and the algal layer is uninterrupted. The two species are not sympatric in South America.

SPECIMENS EXAMINED. – **BRAZIL**: Rio Grande do Sul, *Malme 767* (s, isotype of *A. dissipata*). **COLUMBIA**: Boyaca, Munic, Sutamarchan, near monastery Ecce Homo, c. 12 km NW of Villa de Leiva, 05°41'N, 73°38'S, 2250 m, on boulders in fields in dry inter-andean valley, *Sipman & Reyes 34321*, *Sipman & Reyes 34306* (B); Narino, Munic. Imues, near El Pedregal, towards Tuquerres, on Pasto-Tumaco road, 1°04'N, 77°28'S, 1880 m, *Sipman, et al. 33539* (B); Huila, E slope of Cordillera Central, 1000 m, on sandstone boulders in pasture, *Aguirre & Sipman 6084* (B). **ECUADOR**: Galapagos Islands: Jervis Island. *Weber L-40100* (COLO); Islas Isabela, NW coast between Punta Albemarle and Volcan, *Weber L-63257* (COLO); Isla Rabida, lava talus slope, east side of island, *Weber L-62863* (COLO). **VENEZUELA**: El Pedregal de Jaff, junto a La Carbonera, 2000 m, Figueiras, *Amann, Wirth & Irlet 18168* (NY).

*Acarospora lorentzii* (Müll. Arg.) Hue, Morph. et Anat., p. 162 (1909).

**PLATE 4, FIGURES 13-14.**

DESCRIPTION. – Thallus areolate, to several cm wide, indeterminate or determinate and effigurate. Areoles crowded or dispersed, central areoles from 0.5-1.5 mm wide, usually angular, thin and flat to thick and convex, smooth or developing fissures which results in vegetative division; marginal areoles up to 4 mm wide, comprising several lobes up to 1 mm wide, often fan-shaped and fissured; areoles broadly attached, up to 1 mm thick in the center, with a narrow, white, ecorticate, unattached lower surface beneath a down-turned rim that is sometimes blackened. Upper surface epruinose, usually glossy reddish brown, more rarely matt and dark brown; cortical hyphae originating as hyphal bundles which penetrate the algal layer. Upper cortex 50-90  $\mu\text{m}$  thick, cells various, mostly lacking syncortex or epinecral layer. Apothecia rarely numerous and often absent from most of the central areoles, usually one per areole, often expanding and dominating the areole, appearing as innate lecanorine apothecia; disc immersed, dark brown, flat, rough, epruinose, to 0.5 mm wide, the exciple not forming a parathecial crown. Epihymenium 10-15  $\mu\text{m}$  thick, conglutinated in a reddish-brown to yellow pigmented gel. Hymenium hyaline, 90-145  $\mu\text{m}$  high. Paraphyses ca. 2.0  $\mu\text{m}$  in diam. at mid-level, the apices not expanded or caps pigmented. Asci 80-110 x 16-20  $\mu\text{m}$ , clavate; ascospores 100-200 per ascus, narrowly to rarely broadly ellipsoid, 4-5 x 1.8-2.0(-3.0)  $\mu\text{m}$ . Pycnidia common, ostioles prominent, brown, often many per areole, to 200  $\mu\text{m}$  deep and 100  $\mu\text{m}$  wide. Conidia bacilliform, 1.5-2.5 x 0.5  $\mu\text{m}$ . Spot tests: cortex K+ yellow turning red, forming crystals (on microscope slide). Secondary metabolites: norstictic acid (major),  $\pm$ connorstictic acid (minor),  $\pm$ hyposalazinic acid (trace).

SUBSTRATE AND ECOLOGY. – This species occurs on acid rocks, in open areas at elevations of 600-1500 m.

DISTRIBUTION. – *Acarospora lorentzii* is known from Argentina, Chile, and Uruguay.

DISCUSSION. – *Acarospora lorentzii* can readily be recognized by the high concentrations of norstictic acid present. It is often sterile.

SPECIMENS EXAMINED. – **ARGENTINA:** Buenos Aires, Partido Tornquist, Sierra de la Ventana, 75 km NNE of Bahía Blanca, 38°04' S, 62°00' W, 600 m, on acidic rock, *Nash 23860* (ASU); 30 km W of Olavarría, La China farm house area, 36°40' S, 60°40' W, 150 m, *Nash 26442* (ASU); Catamarca, valley of Rio del Campo, near El Alamito, 1650 m, on granitic rock, *Lamb 5654* (MSC); Mendoza, Campo El Alamo, 20 km E Los Molles, 35°13' S, 69°27' W, c. 1500 m, on acidic rock, *Nash 27537* (ASU); Prov. de Rio Negro, Sierra Grande near Ruta 305, 42°10' S, 63°50' W, 80 m, on acidic rock, *Nash 26478* (ASU); San Luis, Sierra del Gigante, 75 km NW of San Luis, 32°40' S, 66°30' W, c. 730 m, on acidic rock, *Nash 27610* (ASU). **CHILE:** Santiago, Cerro de Ranca, 1896, *Dusén 79* (s, COLO, isotypes of *A. lorentzii* var. *perfecta* H. Magn.); 8 km west of Tiltill, 1000-13000 m, on porphyry boulders, *Weber & Johnson 84122* (COLO). **URUGUAY:** Lavalleja, *Osorio 3744* (COLO).

*Acarospora obnubila* H. Magn, Kungl. Vet.-Akad. Handlingar 7, 4: 263 (1929).

**PLATE 4, FIGURE 15.**

DESCRIPTION. – Thallus areolate to squamulose, dispersed or contiguous when dividing, up to 4 mm in diam. Areoles or squamules, irregular or round, up to 2 mm wide, up to 1-2 mm high, epruinose, becoming fissured and dividing, the rim down-turned or up-turned, quite polymorphous. The stipe can be quite thick and wider than half diameter of squamule, but at that width the squamule usually begins dividing. The upper surface, in a small population, can be very dark blackish-brown to a beautiful light brown. The lower surface is usually white and ecorticate. The cortex is usually  $\pm 70$   $\mu\text{m}$  thick, with thin syncortex which makes it usually look shiny. The algal layer is usually uneven, penetrated by hyphal bands. Apothecia one to several per areole or squamule, punctiform to 1 mm wide, the disc dark brown to reddish-brown, rough, sometimes pseudo-lecanorine and verruciform. Apothecia often surrounded with thalline

collar. The parathecium is indistinct to 10 µm wide. Hymenium usually 120-170 µm thick. Paraphyses 1-2 µm at base in diam., apices usually more closely septate in upper 30 µm, barely expanded to 2-2.5 µm, usually more closely septate in upper 30µm. Epithymenium reddish-brown, 10 µm thick. Subhymenium 30-50 µm thick. Asci usually clavate, 80-125 x 25-35 µm. Ascospores 100 or more spores per ascus, 3-6 x 1-2 µm, usually narrowly ellipsoid, but quite various in size sometimes. Pycnidia are quite common, globose, 50 x 70 µm; conidia 3.0-4.5 x 1-2 µm. Spot tests negative. Secondary metabolites absent.

SUBSTRATE AND ECOLOGY. – On sandstone, granite, and volcanic rock, from 500-3708 meters.

DISTRIBUTION. – In South America *A. obnubila* is known from a single collection from Bolivia. It is known from western North America from California and Arizona. This species could have possibly been reported as *Acarospora smaragdula* sensu Weber (Knudsen 2004).

DISCUSSION. – *Acarospora obnubila* is reported new for South America. It is a non-obligatory juvenile parasite on *Aspicilia* (Knudsen 2007). Some specimens of *Acarospora scabrida* can look similar but have a parathecial crown instead of a thalline collar and an uninterrupted algal layer.

SPECIMENS EXAMINED. – **BOLIVIA**: Potosi: Vinto marble mine, W of Uyuni, S of the Salar, 20°38'15"S, 67°02'34.5"W, 3708 m, on stromatolite, *Reeb 20-V-02/5* (DUKE).

*Acarospora obpallens* (Nyl. ex Hasse) Zahlbr., Beih. Bot. Centralbl. 13: 161 (1902).

**PLATE 4, FIGURE 16.**

DESCRIPTION. – Thallus verrucose. Verrucae contiguous to scattered, usually rounded, 0.2-0.7(-2.0) mm wide, rarely more than 0.5 mm thick, broadly attached. Upper surface pale to dark brown with minute sterile pits and non-radial striations around the apothecia. There is usually a single apothecia per verruca. Algal layer is even. Upper cortex paraplectenchymatous, 20-30(-35) µm thick; cells: round to angular, 3-5 µm wide. Apothecia usually one per verruca; disc immersed, dark brown, epruinose, round, to 1 mm wide. Parathecium narrow. Hymenium hyaline, 100-135 µm tall. Epithymenium reddish-brown. Paraphyses ca. 2 µm diam., apices unexpanded but often with pigmented apices. Asci 90-120 x 13-20 µm, clavate; ascospores 100+ per ascus, ellipsoid, 4-5 x 2 µm. Spot tests: cortex KC+ red. Secondary metabolites: gyrophoric acid (major), lecanoric acid (minor), ±3-hydroxygyrophoric acid (trace), ±methyl lecanorate (trace).

SUBSTRATE AND ECOLOGY. – This species occurs on soil, sandstone, granite, and volcanic rock above 500 meters.

DISTRIBUTION. – In South America this species occurs in Bolivia and Ecuador. *Acarospora obpallens* is very common in western North America and was originally described from southern California.

DISCUSSION. – This is the first report of *A. obpallens* from South America. The specimen from Ecuador is depauperate.

SPECIMENS EXAMINED. – **BOLIVIA**: Potosi, Salar de Uyuni, Isla Inca Huasi, 3650 m., 20° 14'33.8" S 67°37'39.1"W, on volcanic rock with *Acarospora xanthophana*, *Reeb VR 11-V-02/3* (DUKE). **EUCADOR**: Cotopaxi, Parque Nacional Cotopaxi, along road from Pampa de Limpios to summit of Cotopaxi, on lava, *R.C. Harris 17425*, *R.C. Harris 17443* (NY).



*Acarospora rhabarbarina* Hue, Morph. et Anat., p. 117 (1909). *Acarospora rhabarbarina* nom. nov. pro *Lecanora bella* Nyl. non *Lecanora bella* Ach., Lichenogr. Univ., p. 398 (1810). TYPE: CHILE: Quilmenco, Gay s.n. (PC [sheet 1]), lectotype **designated here**). Synonyms: *Acarospora bella* (Nyl.) Jatta *sensu* Magnusson (1929a & b), *Acarospora malmeana* H. Magn., *Acarospora terrestris* (Nyl.) H. Magn., *Lecanora schleicheri* var. *microcarpa* Nyl. (Knudsen 2007).

**PLATE 5, FIGURES 17-21; PLATE 6, FIGURE 22.**

DESCRIPTION. – Thallus areolate, verrucose or squamulose. Areoles, verrucae or squamules dispersed or contiguous, 0.5-2.0 mm wide, ca. 0.5-0.7 thick, round and convex to flat and angular, rim down-turned to undulate in some squamules, propagating by vegetative division; broadly attached, areoles in well-developed specimens becoming stiptate and squamulose. Upper surface usually glossy yellow, smooth but becoming fissured, rarely pruinose; syncortex indistinct to 15  $\mu\text{m}$  thick, eucortex 50-130  $\mu\text{m}$  thick. Lower surface corticate, white to yellow or brownish. Algal layer uniform and even or becoming irregular and interrupted by hyphal bundles in well-developed and dividing specimens (Magnusson, 1929a & b; Hue 1909). Apothecia one to three per areole or verruca, but contiguous thalli may comprise multiple units with multiple apothecia, ultimately forming pin-wheel like agglomerations of reduced apothecia (as in type of *A. malmeana*); disc immersed, deep reddish brown to reddish black (only one specimen seen with pale yellowish apothecia forming pinwheel agglomerations in center), ca. 0.2-0.6 mm in diam., round to rarely slit-like, epruinose, rough. Hymenium 90-110  $\mu\text{m}$  tall, hyaline to pale yellowish. Epithymenium conglutinated in reddish to yellowish brown pigmented gel. Paraphyses ca. 2  $\mu\text{m}$  wide at mid-level, sometimes branching, apices expanded to 3-4  $\mu\text{m}$ . Asci 75-90 x 15-20  $\mu\text{m}$ , clavate; ascospores 100-200 per ascus, broadly ellipsoid, 4-6 x 2-3  $\mu\text{m}$ . Spot tests negative. Secondary metabolites: epanorin (major or trace), and/or rhizocarpic acid (major or trace),  $\pm$ conepanorin (minor),  $\pm$ conrhizocarpic acid (minor),  $\pm$ vulpinic acid (trace). The two chemotypes do not appear to exhibit any differences in geographical distribution, substrate preference or morphological expression.

SUBSTRATE AND ECOLOGY. – This species occurs on exposed volcanic and acidic rocks and adjacent soil above 900 meters elevation.

DISTRIBUTION. – In South America *A. rhabarbarina* is known from Argentina, Bolivia, Chile, and Peru while in North America it is rare in Arizona and California.

DISCUSSION. – This species is widely distributed in the mountains of South America. Magnusson (1929) distinguished *A. malmeana* from other taxa by its multiple apothecia distributed in a wheel-like formation, but such specimens clearly intergrades with others having few or a single apothecium per areole (as in Nash 23897, ASU) from same province and area as the type of *A. malmeana*). Thus this character is definitely not valuable, and specimens of *A. rhabarbarina* exhibit considerable variability. The type of *A. terrestris* (Nyl.) H. Magn. is sterile, but often sterile and fertile specimens occur side by side on both rock and soil (as in Weber & Johnston L-64272 and L-64273, COLO), and *A. terrestris* is a further synonym of *A. rhabarbarina*. The type of *A. chilensis* H. Magn. has apparently been lost, but based on its description (Magnusson 1929b), we suspect that it too represents a morphotype of *A. rhabarbarina*.

Some specimens of *A. rhabarbarina* eventually develop a stipe and become squamulose, appearing superficially similar to *A. socialis* H. Magn., a common species in southwestern North America. However, *A. socialis* does not occur in South America, with the previously reported specimen (Magnusson 1929b) being a mis-determination of *A. rhabarbarina*. *Acarospora socialis* differs in lacking the reddish brown epithymenium and the interrupted algal layer. Nevertheless the distinction of these two species should be confirmed using molecular methods.

The original specimens of this species in PC were first described as *Lecanora bella* by Nylander, but this name was an illegitimate homonym of *Lecanora bella* Ach. Nylander subsequently renamed the species *Lecanora xanthophana* and listed a new type. Apparently Jatta thought the Nylander names applied to two different species and transferred both to *Acarospora* without explanation. While both Hue and Magnusson agreed with his new combination of *xanthophana*, Hue did not accept the *bella* combination. Magnusson later accepted it, but admitted he never examined the specimen which Jatta applied the combination to and had a question mark behind his combination (Magnusson 1929b). Hue recognized that

*Lecanora bella* and *Lecanora xanthophana* were distinct species and described the original specimen of *Lecanora bella* Nyl. in PC as *Acarospora rhabarbarina*. We accept Hue's name and a lectotype is selected here.

**SPECIMENS EXAMINED.** – **ARGENTINA:** Buenos Aires, Sierra de la Ventana, Cerro Ceferino, sobre rocas en la cumbre, 100 m, *Osorio 7110* (COLO); Catamarca, 19 km E Villa Mazan near border with La Rioja, 28°41'S, 66°22'W, c. 900 m, on acidic rock, *Nash 28123* (ASU); Andalgalá, Cuesta de Las Chilcas, near Camp de Pucará, 1920 m, on metamorphic rock, *Lamb 5755* (MSC); Chubut, 14 km E of Pampa de Agoria along Route 25 at turnoff to Colon Conhue, 43°44'S, 69°27'W, 600 m, on acidic rock, *Nash 26562* (ASU); Mendoza, in vicinias montis Aconcagua, Puente del Inca, Malme 1903 (s, isotype of *A. malmeana*); Partido de Las Heras, 10 km SSE of Cerro Aconcagua, 32°48'S, 69°48'W, c. 900 m, on acidic rock, *Nash 23897* (ASU); along route 220 N of San Carlos and 17 km W of El Sosneado, 34°57'S, 69°50'W, c. 1700 m, on acidic rock, *Nash 27560* (ASU); Tucumán, Tapi, Apoima, on rock, *Culberson 14847*, *Culberson 14848* (DUKE). **BOLIVIA:** on soil, *Mandon s.n.* (H-NYL 3441); Chuquisaca, Camargo area, 20°39'07.1"S, 65°11'37.2"W, 2569 m, on sandstone, *Reeb 24-V-02/3* (DUKE); Potosi, Salar de Uyuni, Isla Inca Huasi, 20°14'26.9"S, 67°37'27.2"W, 3650 m, on volcanic rock, *Reeb 12-V-02/5* (DUKE); on the east slope of the volcano Ollaque, close to the minor trail at the level of the shed, 21°17'58.5"S, 68°09'42.9"W, 4930 m, on soft consolidated soil in a slide of volcanic rocks more or less stable, *Reeb 17-V-02/2* (DUKE); Sierra de Rosas, *Mandon* (H-NYL 24936); **CHILE:** Aconcagua, *Follmann 12483* (B); Aconcagua, Cuesta de Chacabuco, *Mattick 259a* (B); Coquimbo, al S de Loa Vilos, Punta Quelén, 10 m, on soil, *Follmann 35061* (B); Coquimbo, *Gay* (H-NYL 3440, determined by Nylander as *Lecanora schleicheri* var. *microcapa* Nyl.); Coquimbo, *Skottsberg s.n.* (s); Concepcion, volcanic rock, *Thaxter* (FH, s); Macama, Les Bombes, *Follmann 14762* (B); Santiago, *Follmann 12296* (B); Santiago, Cerro de Ranca, *Dunsen 85* (COLO); Santiago, 8 km west of Tiltill, on east slope of Cuesta de la Dormida, 1000-1003 m, on porphyry boulder in sun, *Weber & Johnston L-64125* (COLO); NW of Santiago at junction of Caleu and Rungue roads, north of Tiltill, 700 m, on soil and rock or vertical road-cuts *Weber & Johnston L-64272*, *Weber & Johnston L-64273* (COLO); Valparaiso, Cuesta la Dormida, 1300 m, *Mattick 222*, *Mattick 224* (B); **PERU:** Ica, western foothills of Andes 36-40 km E of Nazca on road to Puquio, rhyolite, 2000-2250 m, *Weber & Kohn, L-66453* (COLO); Puno, San Roman, Juliaca, on soil, *Williams 2676* (NY, p.p. w/ *A. xanthophana*).

*Acarospora rouxii* K. Knudsen, Elix & Reeb, in Nash et al. Lich. Flora of Greater Sonoran Region, 3: 26-2. 2007.

#### PLATE 6, FIGURE 23.

**DESCRIPTION.** – Thallus areolate, effigurate or indeterminate to 6 cm wide. Areoles usually contiguous, flat and smooth at first, mostly angular, 1-5 mm wide, but becoming convex, verruculose and rugulose, to 1.5 mm thick in thallus center; in effigurate thalli the outer areoles usually have two short, narrow lobes per areole. Upper surface dull yellow, subdivided by shallow cross-hatching, epruinose, rough with a papillate texture. Upper cortex paraplectenchymatous to subprosoplectenchymatous, 50-100 µm thick, with uneven, obscured hyphae in water or K; syncortex: not evident to thin but indistinct. Algal layer jagged, interrupted by hyphal bands. Apothecia one to five per areole; disc immersed, reddish brown to yellow, less than 0.5 mm wide, sometimes with umbos or ridges of sterile plectenchyma. Parathecium narrow, rarely expanding around disc to form a parathecial crown. Hymenium hyaline to pale yellow, 100-170 µm tall. Epihymenium usually granulose, reddish brown. Paraphyses 1.5-2 µm diam. at mid-level, apices unexpanded or barely expanded. Asci 80-135 x 20-25 µm, clavate; ascospores 100+ spores ascus, broadly ellipsoid, 3-5 x 1.5-2.5 µm. Spot tests: medulla K+ yellow turning red, forming crystals (visible in mounted section). Secondary metabolites: norstictic acid (major), rhizocarpic acid (minor), ±connorstictic acid (trace), ±gyrophoric acid (trace), ±epanorin (trace).

**SUBSTRATE AND ECOLOGY.** – This species occurs on exposed volcanic or acidic rocks above 3000 m.

**DISTRIBUTION.** – In South America this species is known from Bolivia, Chile and Peru. Also known from Mexico and Arizona (where it occurs above 1900 m).

DISCUSSION. – In South America *A. rouxii* can readily be distinguished by its yellow rugulose thallus containing high concentrations of norstictic acid.

SPECIMENS EXAMINED. – **ARGENTINA:** San Luis, Sierra del Gigante, 75 km NW of San Luis, on acidic rock, *Nash 27611* (ASU). **BOLIVIA:** Potosi, on the south slope of the volcano Tunupa, at the level of the second crater starting from Coquesa, 19°50'36.7"S, 67°38'28.5"W, 4920 m, *Reeb 13-V-02/5* (DUKE). **CHILE:** Coquimbo, along the road from Illapel to Coquimbo, *Johnson s.n.* (NY). **PERU:** Junin, Province of Yauli, District of Huay, surroundings of Andaychagua mining unit (Volcan Mining Company), 11°35'S, 75°52'W, 4700–4900 m, mats with *Stipa ichu* and other grasses and exposed rock surfaces and granitic boulders, *Rivas-Plata 304 & Lücking* (F).

*Acarospora strigata* (Nyl.) Jatta, Malpighia, 20: 10 (1906).

PLATE 6, FIGURE 24.

DESCRIPTION. – Thallus areolate or verrucose, to 2 cm wide. Areoles or verrucae dispersed to contiguous, convex, usually pruinose and fissured, 0.2–0.5 mm wide in South American specimens, but up to 3 mm wide in western North American specimens. Upper surface brown beneath pruina. Algal layer ±continuous, depending upon the expanding apothecium. Upper cortex paraplectenchymatous, 45–165 µm thick; cells: 2–3(–5) µm wide; syncortex: (10–)40–50(–100) µm thick, with hyphal cells sometimes visible, sometimes splitting down to eucortex, often in cross-hatch pattern; eucortex: sometimes interspersed, upper layer often with a distinct horizontal reddish line in cross section, 10–15 µm thick; lower layer hyaline and 15–50 µm thick (increasing in thickness with size of areoles); Apothecia usually one per areole; disc blackish to a reddish brown, ±pruinose, rough, to 1 mm wide. Hymenium hyaline, 100–110 (–170) µm tall. Epihymenium brown. Paraphyses 1–2 µm wide, apices not expanded but pigmented brown. Asci 80–120 x 17–27 µm, clavate; ascospores mostly 100 per ascus, broadly ellipsoid, 3–7 x 2–4 µm. Spot test negative. Secondary metabolites: none detected.

SUBSTRATE AND ECOLOGY. – This species occurs on calcareous and acid rocks in exposed, arid locations above 300 meters.

DISTRIBUTION. – In South America, *A. strigata* is only known from historic collections from Argentina (Magnusson 1929b) and Chile. Its center of distribution appears to be in western North America (Knudsen 2007), but it is also known from Asia (Magnusson 1944).

DISCUSSION. – This species is characterized by the usually pruinose areoles, the broad ascospores and the negative spot tests.

SPECIMEN EXAMINED. – **CHILE:** Coquimbo, on calcareous rock, *Gay* (H-NYL 24877, H-NYL 24898, H-NYL 3317).

*Acarospora terrigena* K. Knudsen, Elix & Reeb, **sp. nov.**

MYCOBANK#511451

PLATE 7, FIGURE 25.

Thallus areolatus, fuscus et terrestris. Areolae contiguae, adnatae, 0.2–1 mm latae. Apothecia immersa et haematrista, 0.1–0.5 lata. Rhizohyphae elongatae. Substantia nulla diagnosticae.

**TYPE:** BRAZIL: Rio Grande do Sul, Porto Alegre, 1892, *Malme s.n.* (s, holotype; COLO, isotype) Further isotypes may be deposited in other European herbaria.

DESCRIPTION. – Thallus terricolous, areolate, to 5+ cm wide. Areoles contiguous, 0.3–0.5(–1.0) mm wide, round to angular, separated by deep cracks, subdividing vegetatively. Upper surface yellow-brown,

epruinose, smooth; upper cortex elevated in the center beneath the swelling ascomata and distinguished by a reddish brown color darker than the rest of the areole, thin, to 30  $\mu\text{m}$  thick, with an epinecral layer. Lower surface narrow, ecorticate and stained by the substrate. Apothecia one per areole but subdividing areoles may have 5-6 per areole, with a distinct rim, the rim flat to undulate or down-turned, often pigmented a darker brown; disc reddish brown, not immersed, 0.1-0.3 mm wide, flat, epruinose,  $\pm$ smooth. Algal layer even, 100-200  $\mu\text{m}$  thick. Medulla prosoplectenchymatous, not clearly delineated and mixed with substrate granules and gelatinized hyphae. Parathecium thin, prosoplectenchymous, 50-60  $\mu\text{m}$  thick, pigmented deep red near the surface. Hymenium hyaline, *c.* 200  $\mu\text{m}$  tall. Epihymenium reddish brown, 10-20  $\mu\text{m}$  thick. Paraphyses *ca.* 1  $\mu\text{m}$  wide at mid-level, not clearly septate, with unexpanded apices, sometimes with reddish-brown caps. Asci are 150-160 x 20-30  $\mu\text{m}$ , narrowly clavate to obclavate; ascospores 100-200 per ascus, broadly to narrowly ellipsoid, 4-7 x 1.5-2.5  $\mu\text{m}$ . No pycnidia seen. Spot tests negative. No secondary metabolites detected by TLC and HPLC.

SUBSTRATE AND ECOLOGY. – This species is terricolous on alluvial delta soil.

DISTRIBUTION. – Known only from the type collection from Porto Alegre, Rio Grande do Sul in southern Brazil.

DISCUSSION. – Porto Alegre is a delta formed of alluvial soils deposited at the confluence of five rivers. The area is subtropical with regular precipitation throughout the year and regular radiant fogs and high humidity in the summer. The area has been heavily developed since the type collection was made in 1892. If the species is narrowly endemic to the delta area of the state of Rio Grande do Sul, it may well have been extirpated from most of its original range or is possibly extinct.

Though some characters of *A. terrigena* are similar to that of the *A. smaragdula* group, it differs in having an epinecral upper surface and a continuous algal layer. The thallus of *A. terrigena* is very similar to that of *A. dispersa* H. Magn. from North America (Knudsen 2007). Magnusson (1929b) considered the single specimen of *A. terrigena* (R) that he examined was a poorly developed morphotype of *A. terricola* H. Magn. However, *A. terricola* is distinguished by its dark brown upper surface, punctiform apothecia, and the areoles which arise from anastomosing rhizohyphae rather than vegetative subdivision (Knudsen 2007).

Like other terricolous *Acarospora* species, including *A. brattiae* K. Knudsen, *A. nodulosa* (Duf.) Hue, *A. schleicheri* (Ach.) A. Massal., as well as *A. terricola*, *A. terrigena* has well-developed rhizohyphae and pseudorhizines.

*Acarospora xanthophana* (Nyl.) Jatta, Malpighia 20: 1-10 (1906).

**PLATE 7, FIGURES 26-28.**

DESCRIPTION. – Thallus areolate to subsquamulose, dispersed or contiguous, to 4 cm wide. Areoles irregular to sublobate, 0.5-2.0 mm wide, 0.5-1.5 mm thick, subdividing vegetatively, broadly attached, becoming elevated; underside of the down-turned or lobed rim narrow, usually whitish. Upper surface yellow, dull, smooth but becoming cracked or fissured, often rugulose, epruinose. Upper cortex varying thickness, from very narrow to 30-100  $\mu\text{m}$ , with distinct upper syncortex, hyphae obscure in water or KOH, paraplectenchymatous to prosoplectenchymatous, cells various Algal layer interrupted by broad hyphal bands in thick specimens. Apothecia many per areole; disc punctiform, yellow to brown, 0.1-0.4 mm wide, sometimes surrounded by a slightly elevated parathecial crown concolorous with the thallus. Hymenium 130-200  $\mu\text{m}$  high, the upper portion yellowish, the lower hyaline. Epihymenium yellow. Paraphyses slender, *ca.* 1.5  $\mu\text{m}$  diam. at mid-level, apices not expanded. Asci 100-140 x 15-25  $\mu\text{m}$ , narrowly clavate; ascospores 100-200 per ascus, narrowly ellipsoid, 3-5 x 1.5-2  $\mu\text{m}$ . Pycnidia abundant; conidia ellipsoid, *ca.* 2 x 1.5  $\mu\text{m}$ . Spot tests negative. Secondary metabolites: epanorin (major or minor or trace) and/or rhizocarpic acid (major or minor), sometimes traces of conepanorin.

SUBSTRATE AND ECOLOGY. – Usually this species is found on exposed volcanic and acid rocks above 2000 meters elevation. It also occurs near sea level on Isla Más a Tierra, Juan Fernandez Islands.

DISTRIBUTION. – *Acarospora xanthophana* is known from Argentina, Bolivia, Chile, and Peru.

DISCUSSION. – *Acarospora xanthophana* appears to be endemic to the mountains of South America above 2000 meters.

SPECIMENS EXAMINED. – **ARGENTINA:** Jujuy, Moreno, 3800 m, *Fries s.n.* (COLO). **BOLIVIA:** Larecaja, Viciniis Sorata, Tecacirca, supra Choquecoa pr. Los Aruncheras, cerro de Rosas, *Mandon* (H-NYL 24943, isotype); Potosi, at the foot of the volcano Tunupa, W of the village of Coquesa, along the Salar of Uyuni, 19°54'10.5"S, 67°38'29.8"W, 3690 m, on volcanic rock, *Reeb 15-V-02/3* (DUKE); Refuge of Andean Animals Eduardo Avaroa, Laguna Colorado, on the rocky slope behind the station, 22°10'39.9"S, 67°49'31.3"W, 4350 m, on volcanic rock, *Reeb 19-V-02/5* (DUKE); on the road from Uyuni to Potosi, between Ollerias and Ticatica, 20°14'28.5"S, 66°25'24.6"W, 3800 m, on sandstone, *Reeb 21-V-02/1* (DUKE); Salar de Uyuni, Isla Inca Huasi, 20°14'36.2"S, 67°37'38.2"W, 3650 m, on cement of conglomerate, *Reeb 11-V-02/9* (DUKE); 20°14'26.9"S, 67°37'27.2"W 3650 m, *Reeb 17-V-02/7* (DUKE). **CHILE:** Cordillera de los Patos, *Gay* (H-NYL); Iquique, Isulaga National Park, Enquelga, 19°15'S, 68°43'W, 3690 m, *Quilhot 1471* (UV); Juan Fernandez Islands, Isla Más a Tierra, Puerto Frances, Valley, sea level, *Imshaug 38006* (FH); Puerto Ingles, rocky shore at landing place at end of the bay, sea level, *Imshaug 37881* (MSC); Santa Clara Island, El Morro del Spartán, 10 m, *Imshaug 38218-A* (MSC); Loa, above Puritana, 4000 m, *Follmann 34408* (B); Lquique: Mountain ridge above Mamina, 3200 m, *Follmann 34409* (B); Museum Botanicum Berolinense, El Tarapaca, precordillera NE of Mamina, 2900 m, *Follmann 34353* (B); NE of Mamina, 2500 m, *Follmann 34224* (B); PERU: volcano of Misti, near Arequipa, 4389 m, *Bailey s.n.* (FH).

*Pleopsidium chlorophanum* (Wahlenb.) Zopf, Ann. Chem., 284: 117 (1895).

Illustrations: see Wirth p. 751 (1995); Bulletin of the California Lichen Society 12:1 (2005), back cover, <http://californialichens.org/bulletin/index.html>

DESCRIPTION. – Thallus areolate or squamulose, orbicular, up to 2 cm wide, the margin ±distinctly effigurate. Areoles or squamules to 3 mm wide, marginal lobes poorly developed, 0.5-1(-2) mm long, up to 1 mm thick. Upper surface yellow-orange, epruinose. Upper cortex 40-60 µm, cells various. Algal layer even. Apothecia numerous, usually one per areole, 1-3 mm wide; disc pale yellow, lecanorine, flat, becoming convex and the margin excluded, biatorine. Parathecium 50-80 µm thick, narrowing in hypothecium. Hymenium hyaline, 50-70 µm high. Epithymenium yellow-brown. Paraphyses ca. 2 µm wide at mid-level, apices barely expanded. Asci 70-80 x 15-20 µm, clavate; ascospores 100-200 per ascus, hyaline, simple, ellipsoid, 3.5-4.5 x 1.5-2 µm. Pycnidia immersed; conidia, ellipsoid, 3-4 x 1.5-2 µm. Spot tests negative. Secondary metabolites: rhizocarpic acid (major), acaranoic acid (minor), and acarenoic acid (minor).

DISTRIBUTION. – In South America this species is known from Argentina. It also occurs in Antarctica, Asia, Europe and North America.

DISCUSSION. – This distinctive species is characterized by its yellow apothecia with thalline margin finally excluded, and squamulose thallus.

SPECIMENS EXAMINED. – **Argentina:** Provincia de De Neuquen: Partido de Collon Cura, 11 km NE of the junction of routes 40 & 237 along route 237, 40°24'S, 70°31'W, 880 m, on acidic rock, *Nash 24156*, *Nash 24157* (ASU).

## CONCLUSION

Thirteen species of *Acarospora* and one of *Pleopsidium* are discussed in this paper but it is obvious that further work is needed to complete a comprehensive revision of Acarosporaceae in South America. Older literature records need to be revisited and more specimens need to be examined. A number of type specimens were not examined during this study including *A. brasiliensis* Zahlbr., *A. catamarcae* H. Magn., *A. punae* I.M. Lamb, *A. regnelliana* R. Sant., *A. sparsiuscula* H. Magn., *A. trachyticola* (Müll. Arg.) Hue, and *A. theleomma* I.M. Lamb. These species are in need of detailed study and taxonomic assessment. More extensive collecting is obviously needed.

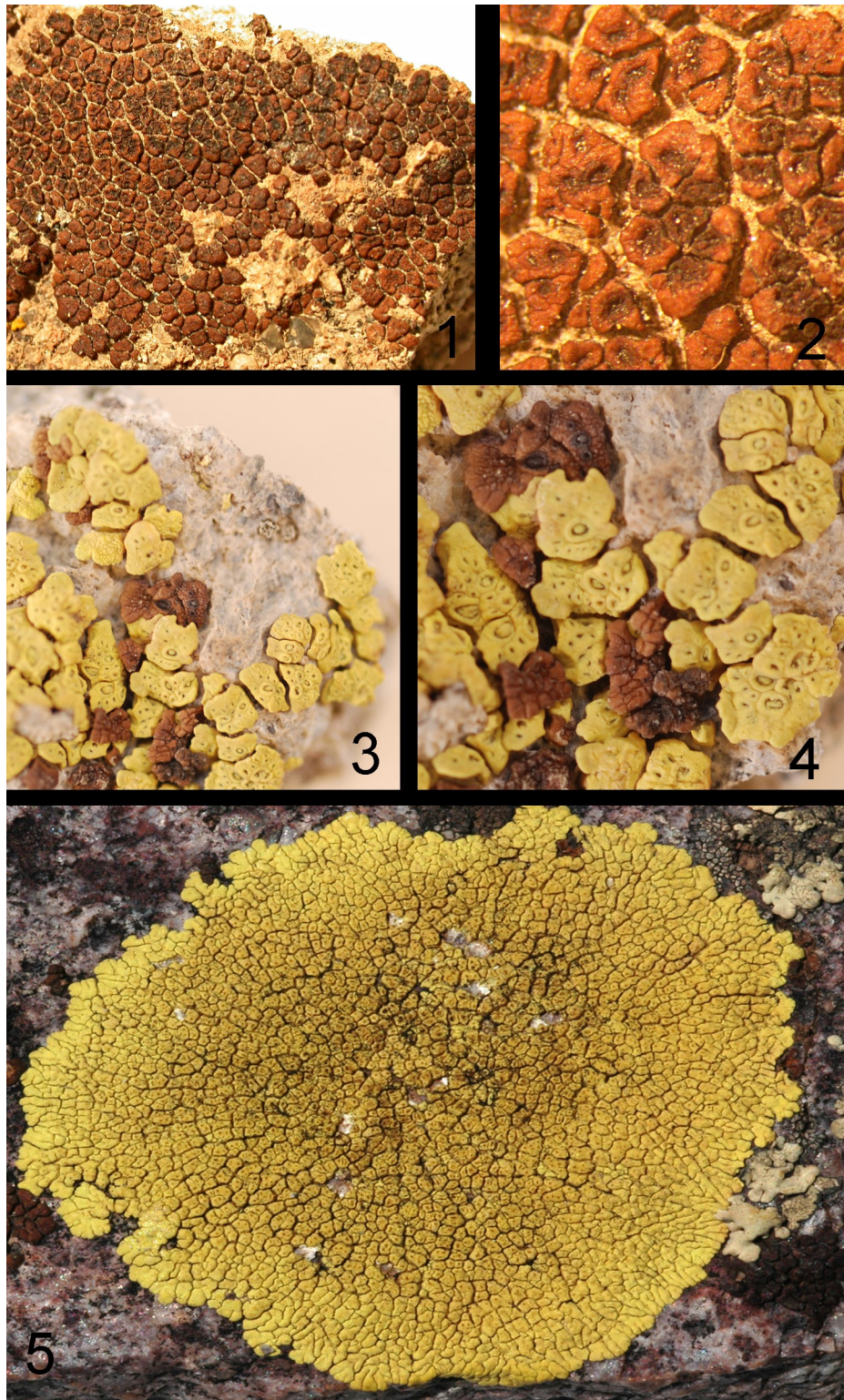
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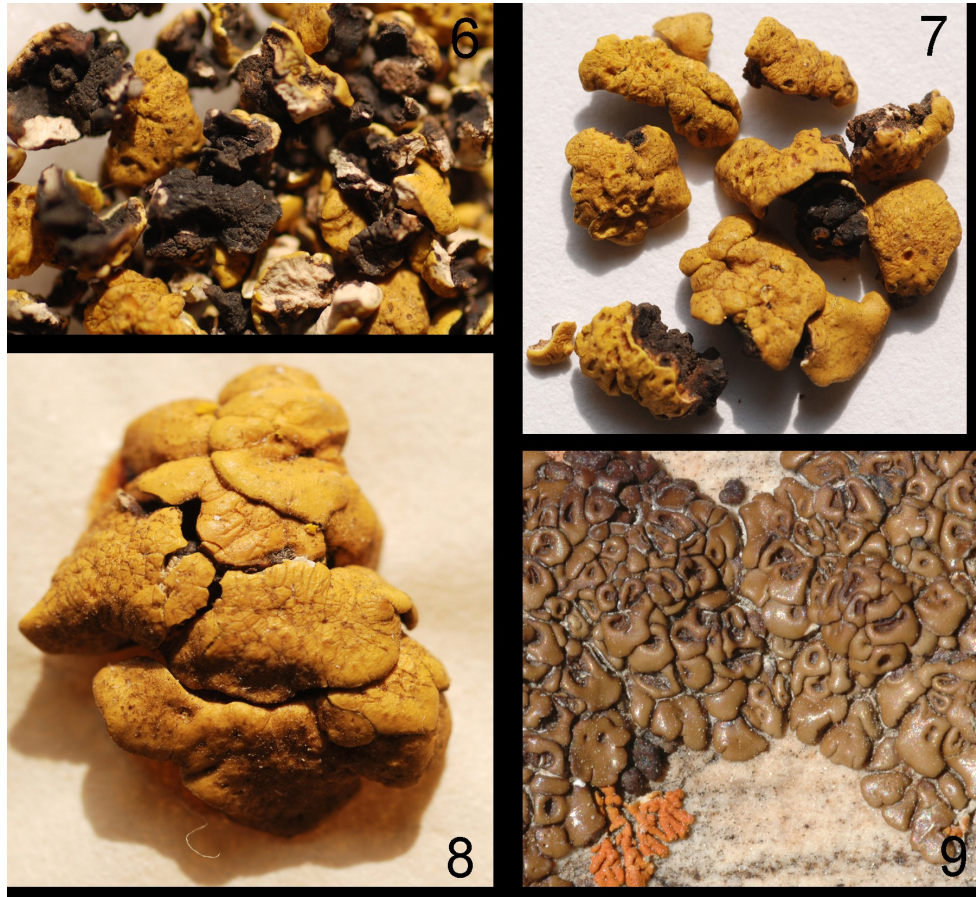
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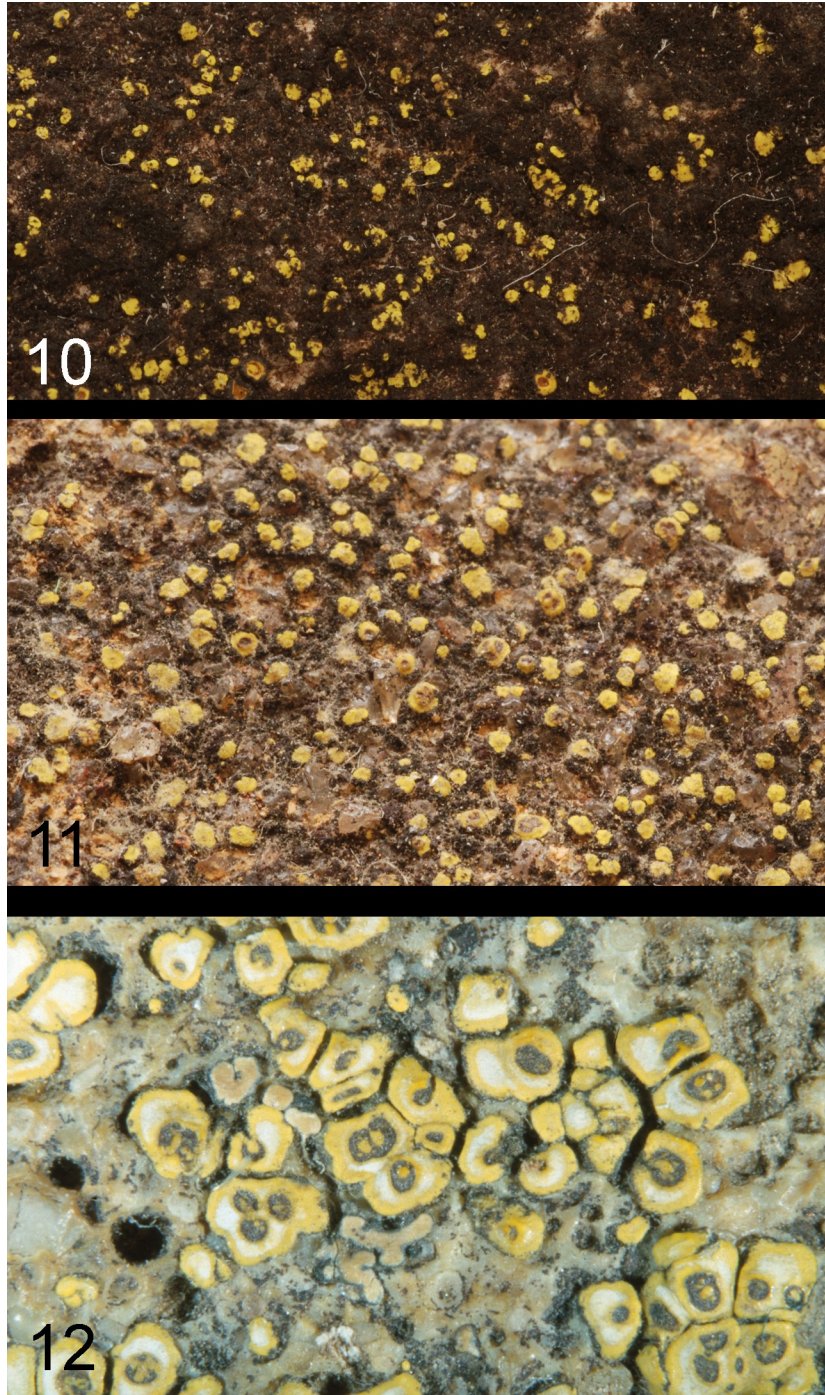


**Plate 1. Figures 1-2, *Acarospora altoandina*, holotype (Cabrera s.n., UPS), images by A. Nordin. Figures 3-4, *A. altoandina* (Reeb 14-V-02/4, DUKE), images by J. Good. Figure 5, *A. boliviana*, netotype (Mattick 701, B), image by J. Good.**

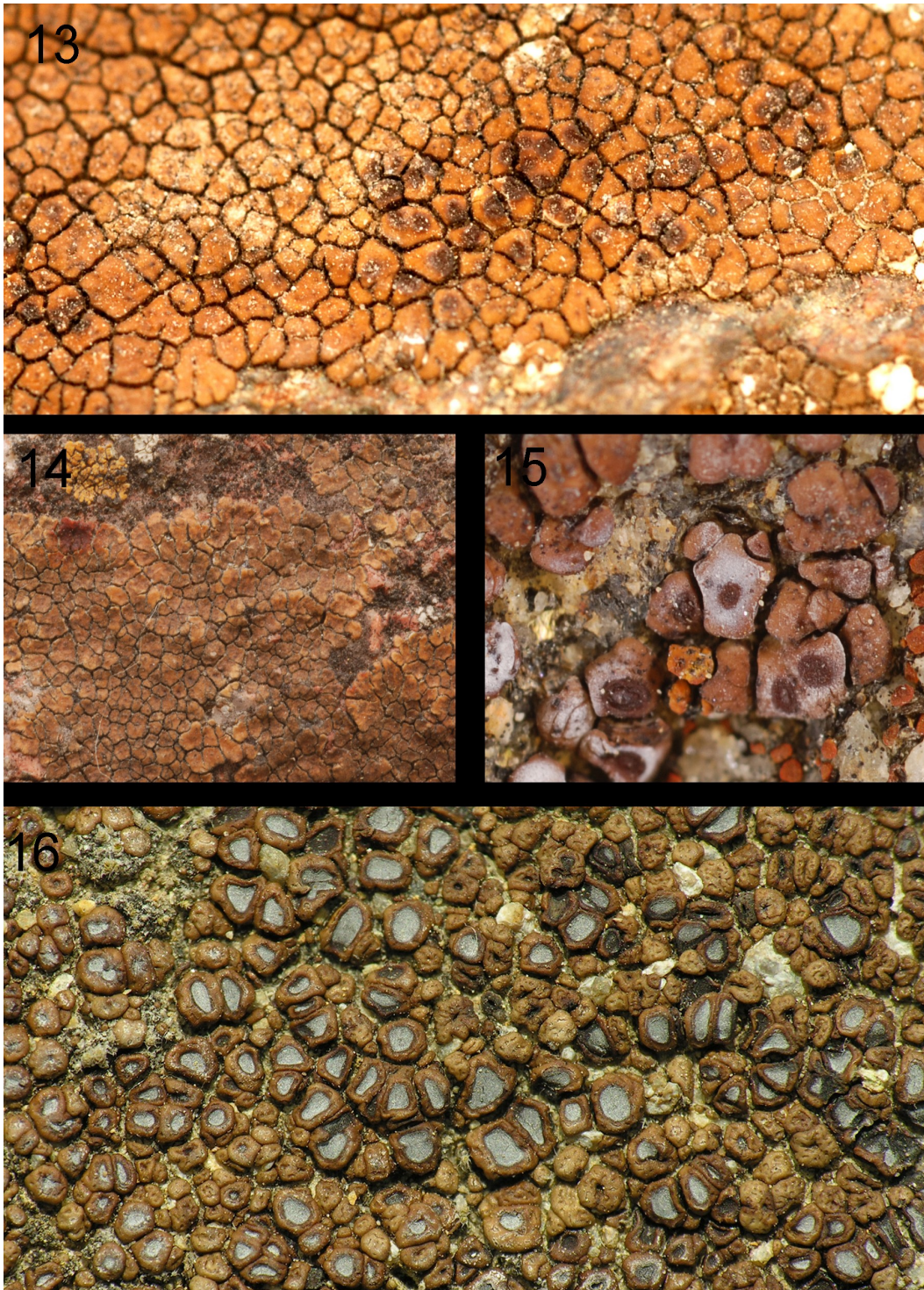




**Plate 2. Figures 6-8, *Acarospora brouardii*, isotype (*Arsène 10730*, US), images by J. Good. Figure 9, *A. bullata* (*Knudsen 3351*, UCR), image by J. Good.**



**Plate 3.** **Figure 10**, *Acarospora chrysops*, isotype of *A. dissipata* (Malme 767, S), image by J. Good. **Figure 11**, *A. chrysops*, lectotype (Ravenel 424, FH), image by J. Good. **Figure 12**, *A. chrysops* (Weber L-62863, COLO), image by J. Good.



**Plate 4. Figure 13, *Acarospora lorentzii*, (Nash 27610, ASU), image by J. Good. Figure 14, *A. lorentzii*, (Osorio 3744, COLO), image by J. Good. Figure 15, *A. obnublia* (Knudsen 5426, COLO), image by J. Good. Figure 16, *A. obpallens* (field image from Santa Ana Mountains, Orange Co., CA), image by R. Muertter.**

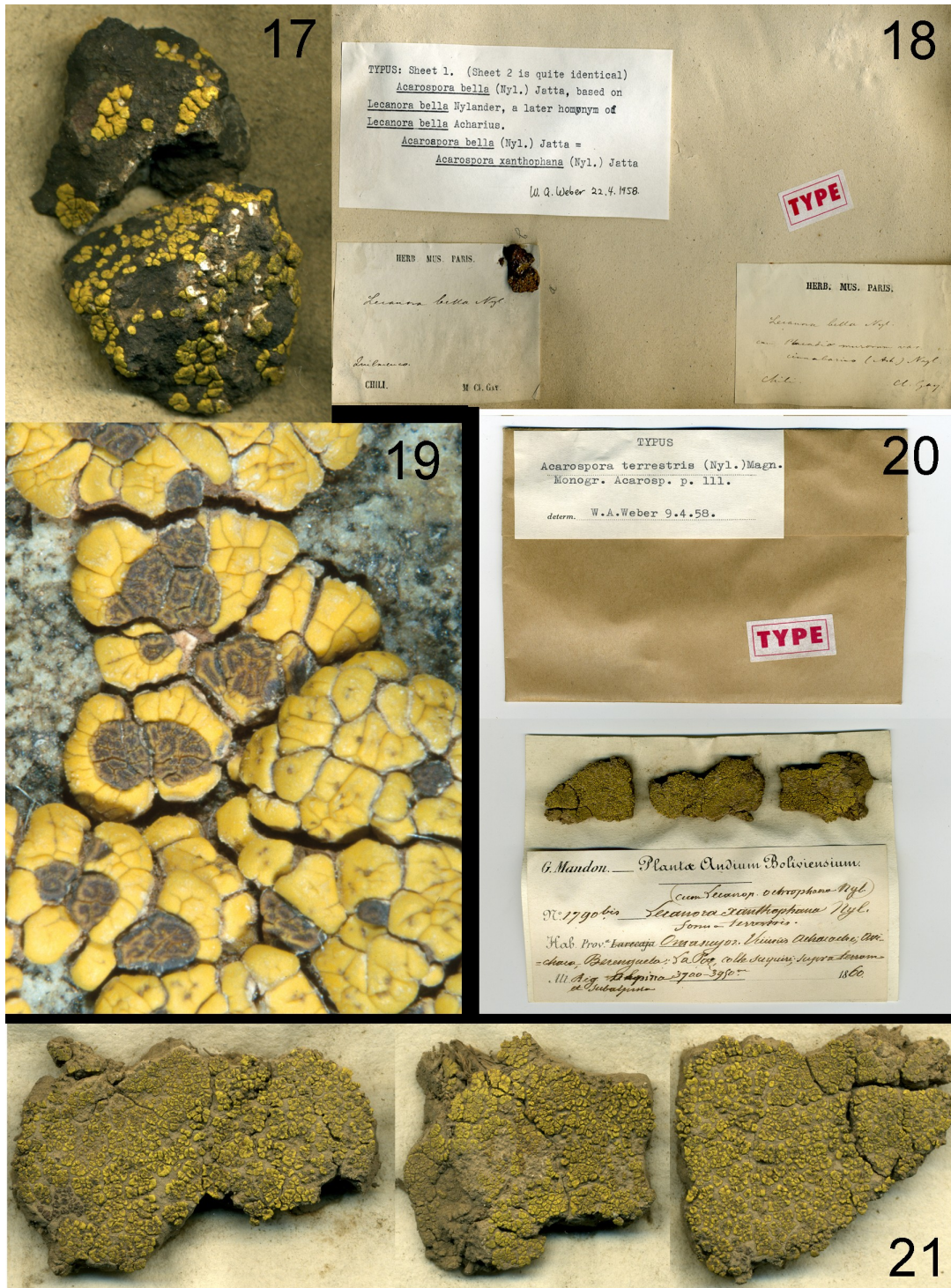
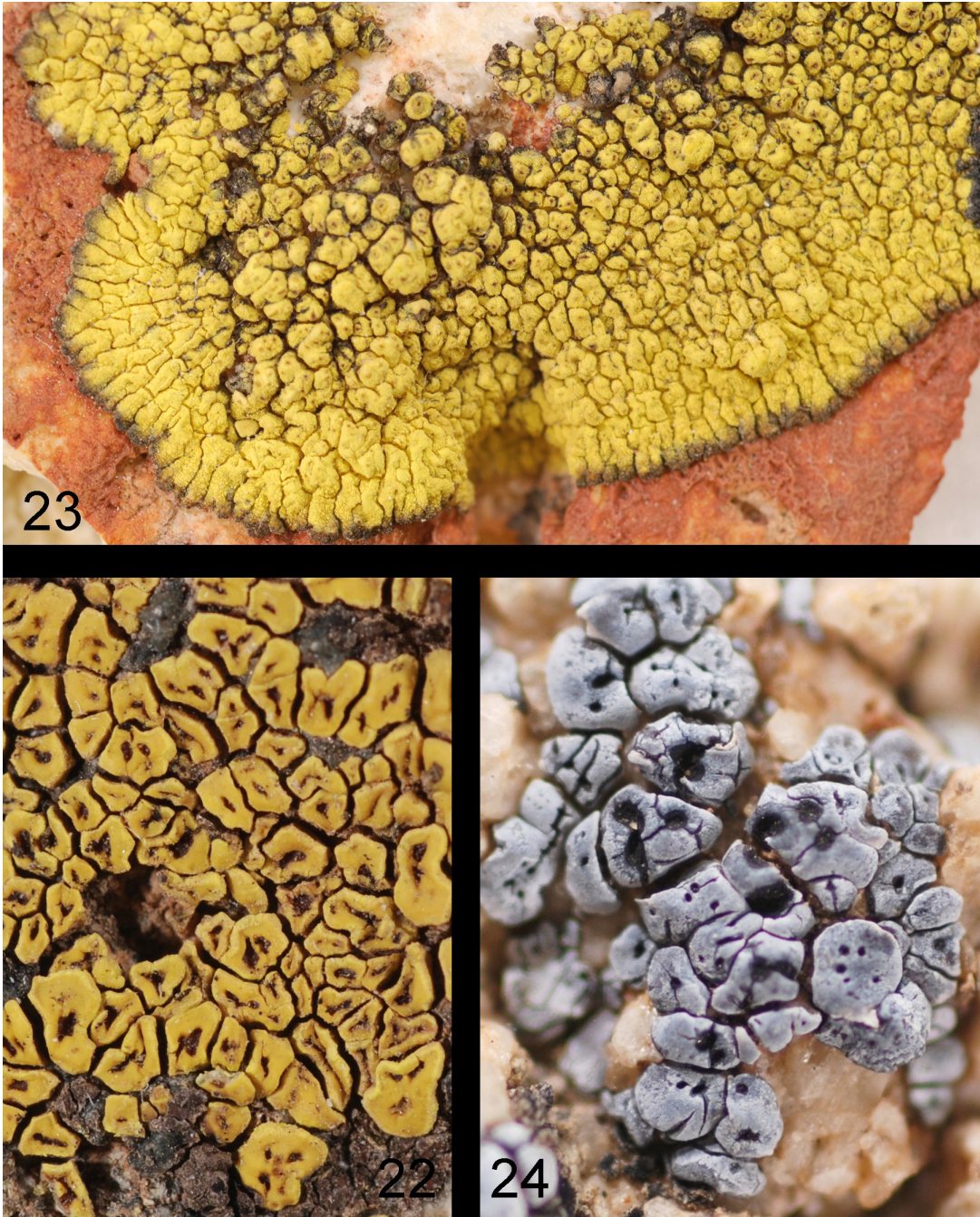
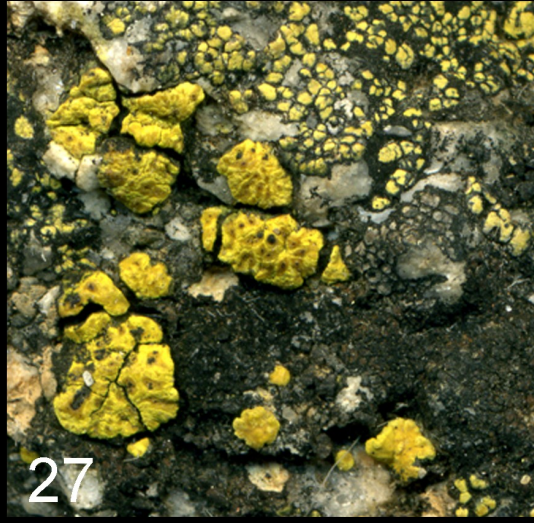


Plate 5. Figures 17-18, *Acarospora rhabarbarina*, lectotype (Gay s.n., PC), image by staff of PC. Figure 19, *A. rhabarbarina*, holotype of *A. malmeana* (Malme 1903, S), image by R. Schröder. Figures 20-21, *A. rhabarbarina*, holotype of *A. terrestris* (Mandon 1790bis, PC), images by staff of PC.



**Plate 6. Figure 22**, *Acarospora rhabarbarina*, (Weber L-64125, COLO), image by J. Good. **Figure 23**, *A. rouxii*, (Reeb 13-V-02-5, DUKE), image by J. Good. **Figure 24**, *A. strigata*, (Knudsen 2638, UCR), image by J. Good.



**Plate 7. Figure 25, *Acarospora terrigena*, holotype (*Malme s.n.*, S), image by J. Good. Figures 26-27, *A. xanthophana*, holotype (*Mandon s.n.*, PC), image by staff of PC. Figure 28, *A. xanthophana*, (*Reeb 4-V-02*, DUKE), image by J. Good. Figure 29, *A. xanthophana*, (*Follmann 34224*, B), image by J. Good.**